REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*
11/14/2002

2. REPORT TYPE
Final Technical Report

3. DATES COVERED *(From – To)*
6/10/2001 – 5/31/2002

4. TITLE AND SUBTITLE
Sidescan Sonar Observation of Bedform/Mine Interactions

5a. CONTRACT NUMBERS

5b. GRANT NUMBER
N00014-01-1-0963

5c. PROGRAM ELEMENT NUMBER

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

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8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING/MONITORING ACRONYM(S)

11. SPONSORING/MONITORING AGENCY REPORT NUMBER

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT
Our research program focuses on identifying and quantifying sediment erosion, transport, and deposition processes on the continental shelf through state of the art observational techniques in both fine grained and sandy environments. In sandy environments our goal is to understand the detailed interactions and feedbacks between hydrodynamics, bedforms, and the resulting sand transport. In fine grained environments we have been investigating the role of fluid mud flows as a depositional mechanism in areas with high deposition rates.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES
Unclassified	Unclassified	Unclassified	UL	12

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508-289-2638

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI-Std. Z39-18

122111

Sidescan Sonar Observation of Bedform/Mine Interactions

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N00014-01-10963

LONG-TERM GOALS

Our research program focuses on identifying and quantifying sediment erosion, transport, and deposition processes on the continental shelf through state of the art observational techniques in both fine grained and sandy environments. In sandy environments our goal is to understand the detailed interactions and feedbacks between hydrodynamics, bedforms, and the resulting sand transport. In fine grained environments we have been investigating the role of fluid mud flows as a depositional mechanism in areas with high deposition rates.

OBJECTIVES

Under funding from this grant we wanted to develop rotary sidescan sonar systems to observe Bedform/Mine Interactions. We also planned to conduct an initial deployment of the systems with an optical instrumented mine in collaboration with Michael Richardson of N.R.L. Stennis. Previously most mine burial models have focused on single mechanisms such as a large bedform migrating over a mine or scour allowing the mine to sink into the seafloor. With data from this initial deployment we planned to examine if these processes were coupled, as scour pits could serve as an initiation site for the generation of bedforms or migrating bedforms could fill scour pits. Understanding these processes will allow better prediction of mine burial in sandy environments.

APPROACH

To investigate the interactions of mines and bedforms we have developed and deployed a rotary sidescan sonar system to image an instrumented mine that will be deployed by Mike Richardson from N.R.L. The mine/sonar deployments will occur in both coarse and fine sand environments at the MVCO to study the interactions with both large and smaller scale bedforms.

WORK COMPLETED

We purchased two Imagenex digital rotary sidescan sonars and have designed and built and data acquisition system for the sonars based on a Persistor CF1 data logger with a Big IDEa disk drive adapter that allows use of compact form PCMCIA 2Gb hard drives. The data acquisition system can either operate in autonomous mode with battery power or operate connected to the MVCO node.The software was designed with a flexible interface to allow it to control either rotary sidescan sonars or rotary pencil beam sonars.

Two rotary sonars with Nortek ADVs were deployed during the winter of 2001-2002 (Figure 1). One was deployed in the coarse sand to study the geometric evolution and migration of orbital scale ripples independent of a mine. The second was deployed within the field of view of an instrumented mine to investigate the interactions between the scour pit and bedforms in mine burial. In work

planned for winter 2002-2003 we will deploy the instrumented mine in coarse sand to investigate the interactions of the larger orbital scale ripples with the scour pit.

RESULTS

The site characterization work completed to date has revealed an interesting sandy sedimentary environment with the predominant features being the rippled scour depressions. The simultaneous Rotary Sonar Sampling and grab sampling shows that the rippled scour depressions contain coarse sand while the surrounding areas have a surface layer of fine sand. Cores revealed that this surface layer of fine sand is only 20-40 cm deep and is underlain by coarser sands. The coarse sands are capable of supporting large-scale (up to 1 m wavelength and 15cm height) wave orbital scale bedforms (Figure 2), while the finer sands contain smaller (10-15 cm wavelength, 1.5-2.5 cm height) an-orbital scale bedforms (Wiberg and Harris, 1994; Traykovski et al, 1999). The orbital ripples generally migrate in the direction of wave propagation forced by wave velocity skewness as observed previously. However, an interesting feature emerged in this data set as our previous data sets contained no events with r.m.s velocities of over 45 cm/s. At MVCO when velocities exceeded 45 cm/s the linear orbital scale ripples became irregular, with complex three dimensional shapes. They occasionally displayed characteristics of lunate mega ripples (Figure 1).

The second sonar that was deployed in fine sand within the field of view of the N.R.L. instrumented mine produced two data sets on mine burial. The mine was initially deployed from Dec. 2001 to Feb 2002. During this period it buried completely in 38 days (Figure 3). It was the redeployed until July 2002, during which it did not bury completely. Results from the first deployment have been published in a proceeding paper (Richardson and Traykovski, 2002). While the development of the large scour pit, which subsequently infilled with fine sediment appears to be the dominant process in mine burial here, there also appears to be some dependence on the migration or evolution of a medium scale bedform field. During the first deployment, in which the mine buried completely, there were elevation changes of up to 15 cm underneath the sonar. During the second deployment the elevation changes were only 5 to 8 cm. These bedforms were not resolved in the rotary sidescan imagery, but the elevation changes were resolved by the first return of the rotary sonar from the seafloor. High resolution multibeam bathymetric surveys performed by Larry Meyer of U.N.H. revealed medium scale bedforms of 4 to 8 wavelength and 10 to 15 cm height in the fine sand at MVCO. These medium scale bedforms with low amplitude would not be likely to be resolved with the rotary sidescan sonar system. We think the migration of these bedforms may have played an important role in the complete burial of the mine in the first deployment as sand, perhaps associated with the bedform migration, was able to cover the fine sediment that had filled the scour pit.

TRANSITIONS

The primary transition to applications in these two projects will occur through the collaboration with N.R.L. investigator Mike Richardson and Mine Burial Prediction modelers such as Carl Freidrichs at VIMS and Scott Jenkins and Doug Inman at Scripps. Carl Freidrichs has already used this data set to tune modifications to an existing mine burial model (Drambuie from the UK) for this environment. Understanding these mine scour / bedform interaction processes will allow better prediction of mine burial in sandy environments.

RELATED PROJECTS

This project is closely related to the "Using a near bed sediment flux sensor to measure wave formed bedform migration and formation processes," and the "Development of a near bed sediment flux sensor" projects. In these projects we are building and planning to deploy an instrument which will

allow us to measure the near-bed sediment flux which is important in determining bedform characteristics. An increased knowledge of bedform processes should help better understand the interactions between the bedforms and mine burial processes. Some of the processing algorithms that we are using in the near bed flux sensor could also be applied to the acoustically instrumented mine that is being developed by NRL and OMNI Technologies.

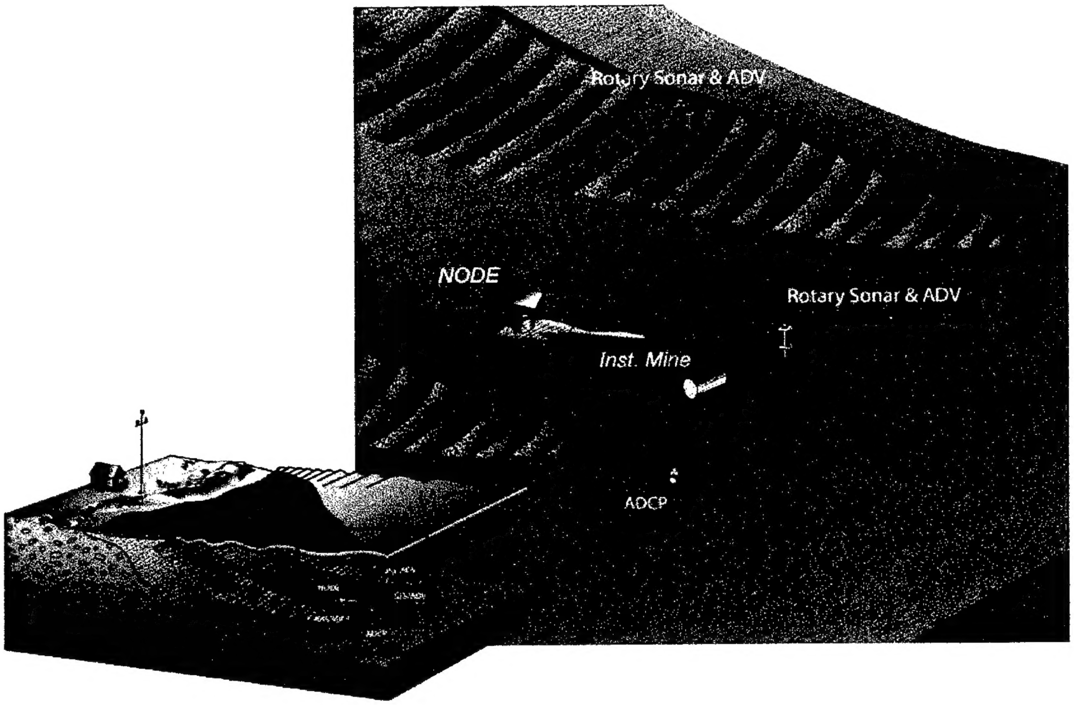

Figure 1. Martha's Vineyard Coastal Observatory Instrumented Mine Deployments

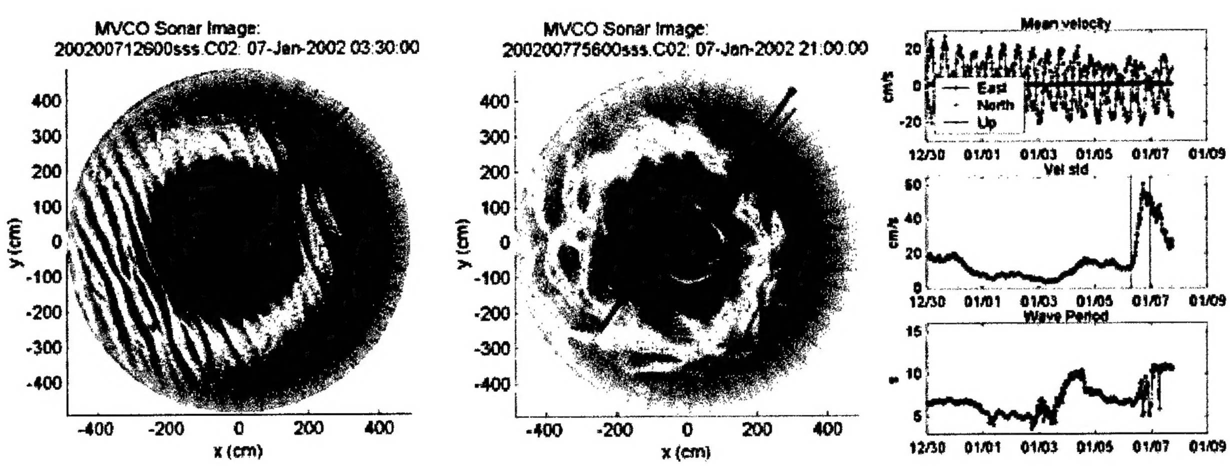

Figure 2. Transition of bedforms from linear orbital scale ripples to irregular three dimensional lunate ripples in coarse sand at MVCO during a high energy event.

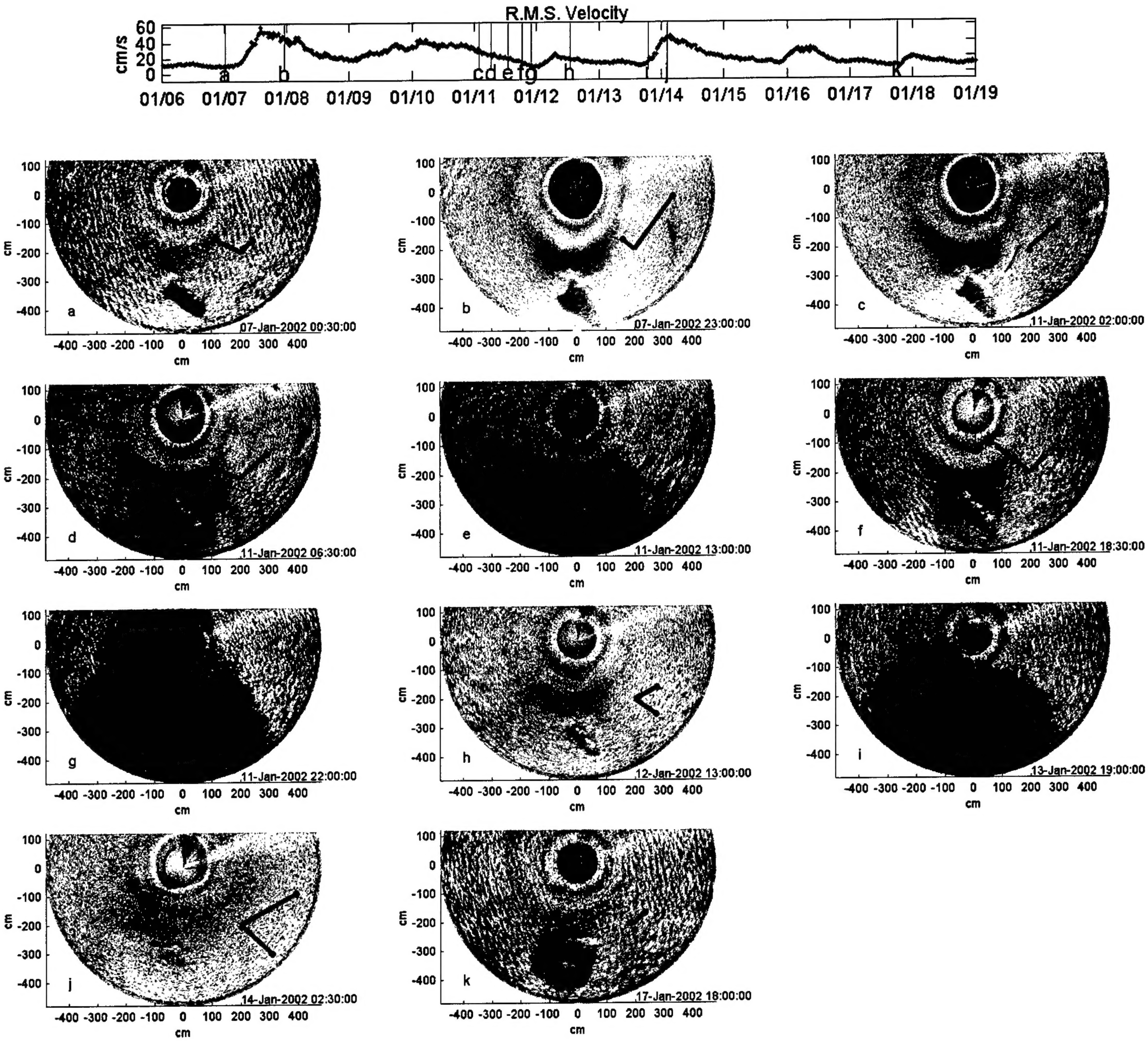

Figure 3. A period of high energy waves in which the instrumented mine become completely buried. A large scour pit develops between 1/07 and 1/08 during the 60 cm/s rms velocity waves. This scour pit begins to fill with fine sediment on 1/11. The fine sediments are washed out of the scour pit 1/11:18:30 as the current (blue arrow) picks up. This process of infilling with fine sediment and then removal of fine sediment repeats over next several periods of high waves and currents. By Jan 14th the mine has been completely buried except for a small corner which is exposed then buried over the next few weeks. By Feb 20th the mine is completely buried and no trace of it is visible in the bedform field.

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